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1981
AIR MONITORING REPORT
CITY OF CALGARY

Alberta
ENVIRONMENT

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1981
Air Monitoring Report
City of Calgary

prepared by

AIR QUALITY CONTROL BRANCH

POLLUTION CONTROL DIVISION

ENVIRONMENTAL PROTECTION SERVICES

ALBERTA ENVIRONMENT

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SYNOPSIS

This report is an assessment of the ambient air quality in the city of Calgary for the 1981 report year. The assessment is based on the results of the monitoring of various air pollutants by the Air Quality Control Branch of the Pollution Control Division of Alberta Environment from January 1, 1981 to December 31, 1981.

The emphasis is on comparing the data with the levels outlined in the Alberta Clean Air (Maximum Levels) Regulations.

The air quality indices--numerical indicators of air quality, which are based on readings of sulphur dioxide, ozone, carbon monoxide, suspended particulate matter, and nitrogen dioxide--are also discussed in this report. Generally, the air quality was in the 'good' index range.

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I. INTRODUCTION

The Air Quality Control Branch of Alberta Environment operates an on-going program of ambient air monitoring in the city of Calgary. The objectives of this program are twofold: to provide data for the assessment of existing air quality; and to establish long-term trends in air quality. To achieve these goals, the Branch operates a comprehensive network of stations equipped to measure oxides of nitrogen, ozone, carbon monoxide, sulphur dioxide, total hydrocarbons, particulates and total sulphation.

The report summarizes the results of the monitoring of these air pollutants from January 1, 1981 to December 31, 1981.

The data obtained during this report year are compared with the air quality Regulations, which stipulate the maximum permissible concentrations of contaminants in the ambient air. The "maximum permissible concentrations" are listed in the Alberta Clean Air (Maximum Levels) Regulations.

The "Source and Emission Inventories" for the pollutants are cited to provide information on the contribution of each major source (e.g. industry and motor vehicles) to the total emissions of each pollutant.

II. THE AIR MONITORING NETWORK

The network of air monitoring stations in the city of Calgary is comprised of two units: the continuous ambient air monitoring network, which collects data on oxides of nitrogen, ozone, carbon monoxide, sulphur dioxide and total hydrocarbons; and the static and intermittent air monitoring network, which samples total sulphation and particulates - soiling index, suspended particulate matter (high volume sampler) and total dustfall.

Figure 1 illustrates the locations of the three continuous air monitoring stations. The stations are designated CDMU, CRMU and CIMU. The designations refer to the general locations of the stations in the downtown, residential and industrial areas respectively. Table 1 lists the parameters that each station is equipped to monitor continuously and gives additional information about the stations.

The locations of the static and intermittent air monitoring stations are also shown in Figure 1. This network of stations is comprised of 28 exposure sites for measuring total sulphation and total dustfall, and three sites for measuring soiling index and suspended particulate matter.

FIGURE 1

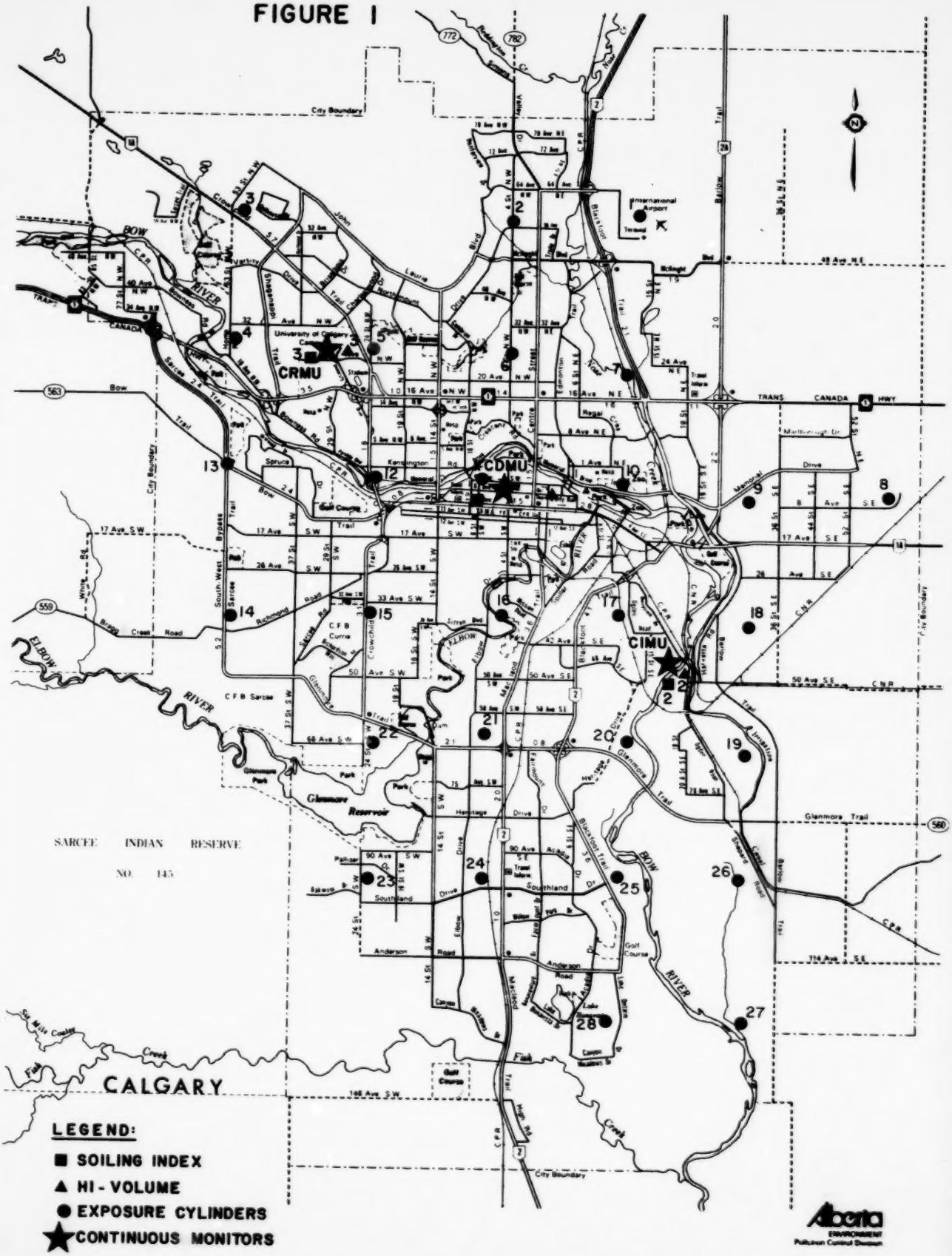
CRMU
CDMU
CIMU
CALGARY
SARCEE INDIAN RESERVE NO. 145
Glenmore Reservoir
BOW RIVER
ELBOW RIVER
LEGEND:
SOILING INDEX
HI-VOLUME
EXPOSURE CYLINDERS
CONTINUOUS MONITORS
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TABLE 1

THE CONTINUOUS AMBIENT AIR MONITORING NETWORK

Parameters that Stations are Equipped to Monitor Continuously

Station	Wind	NO_x	NO_2	O_3	CO	SO_2	THC
CDMU	-	x	x	x	x	x	x
CIMU	x	x	x	x	x	x	x
CRMU	x	x	x	x	x	x	x

Note: CDMU - Calgary Downtown Monitoring Unit
CIMU - Calgary Industrial Monitoring Unit
CRMU - Calgary Residential Monitoring Unit

NO_x - Oxides of Nitrogen
NO_2 - Nitrogen Dioxide
O_3 - Ozone
CO - Carbon Monoxide
SO_2 - Sulphur Dioxide
THC - Total Hydrocarbons

Station Documentation

Station	Station Address	Height of Station	Height of Sample Inlet Above Ground
CDMU	4 St. and 6 Ave. S.W.	4 m	6 m
CIMU	18A St. and 45 Ave. S.E.	3 m	4 m
CRMU	39 St. and 29 Ave. N.W.	3 m	4 m

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Air Quality Control Branch

III. THE AIR MONITORING INSTRUMENTATION

The detection principles and sampling periods of the pollutants monitored during the 1981 report year are presented in Table 2. Also included are the methods used to calibrate the instruments and the type of monitoring that was employed for each pollutant.

There are three basic types of ambient air monitoring, and they differ on the basis of the duration of the sampling periods: continuous, static and intermittent. Continuous monitoring is the sampling of the air on a continuous basis; static monitoring involves time periods of approximately 30 days; and intermittent monitoring encompasses 1-hour, 2-hour and 24-hour sampling time periods.

Monitoring of ambient air may also be categorized according to the method used for analyzing the sample, automatic or manual. Automatic analysis is accomplished by a system which has the capability of collecting the sample, analyzing it and giving a data read-out. This is exemplified by the monitoring of oxides of nitrogen, ozone, carbon monoxide, sulphur dioxide and total hydrocarbons. Manual analysis involves the collection of a sample and subsequent analysis at a laboratory. The monitoring of particulates and total sulphation are examples of the manual method.

TABLE 2

THE AIR MONITORING INSTRUMENTATION

Pollutant	Detection Principle	Sampling Period	Type of Monitoring	Instrument Calibration Method
Nitrogen Dioxide	Chemiluminescence	Instantaneous (sample integration)	Continuous	Permeation tube or Gas Phase titration
Ozone	Chemiluminescence or Ultraviolet photometry	Instantaneous (sample integration)	Continuous	Buffered potassium iodide or Gas phase titration
Carbon Monoxide	Nondispersive infrared radiation	Instantaneous (sample integration)	Continuous	Certified gas cylinder
Sulphur Dioxide	Coulometric detection or Pulsed fluorescence	Instantaneous (sample integration)	Continuous	Permeation tube
Total Hydrocarbons	Flame ionization	Instantaneous (sample integration)	Continuous	Certified gas cylinder
Suspended Particulate Matter (Soiling Index)	Tape sampler (light transmittance)	1-hour or 2-hour	Intermittent	Rotameter - flow
Suspended Particulate Matter (High-Volume Sampler)	Gravimetry	24-hour	Intermittent	Orifice plates/mass flow detection
Total Sulphation	Chemical reaction	30 days	Static	N/A
Total Dustfall	Gravimetry	30 days	Static	N/A

IV. AIR POLLUTANT DATA ANALYSES

A. INTRODUCTION

In this section of the report, the pollutants are examined on an individual basis. The presentation includes general information on the pollutants, an overview of the prime emission sources as determined by the 1973 Source and Emission Inventory and an analysis of the data.

For the purposes of this report, the data are summarized. The summaries include arithmetic mean concentrations and the frequency of occurrence of concentrations in compliance with the Clean Air (Maximum Levels) Regulations.

Sufficient data must be available to constitute valid calculated mean values. When the instrument operational time is less than 50%, no arithmetic mean is calculated; and when the instrument is operational between 50% and 75% of the time, the arithmetic mean may not be representative of that period. Therefore, any comparisons of the data should take this into account.

Tables 3 and 4 are included to provide an overall picture of existing air quality and to give some idea of the trends of the air pollution levels over the past five years. Starting with the 1982 annual report, a detailed trend analysis section will be included.

TABLE 3

POLLUTANTS COMPARED WITH CLEAN AIR REGULATIONS[1]

1981

POLLUTANT	PERCENT COMPLIANCE WITH REGULATIONS[1]			AIR QUALITY REGULATIONS
	CDMU	CIMU	CRMU	
Nitrogen Dioxide				
1-hour	100	100	100	0.21 ppm
24-hour	100	100	100	0.11 ppm
Ozone				
1-hour	99.99	100	99.95	0.080 ppm
24-hour	97.46	96.31	67.92	0.025 ppm
Carbon Monoxide				
1-hour	99.26	99.72	99.93	13.0 ppm
8-hour	94.24	96.05	98.21	5.0 ppm
Sulphur Dioxide				
1-hour	100	100	100	0.17 ppm
24-hour	100	100	100	0.06 ppm
Suspended Particulate Matter (Soiling Index-COH)	91.67	74.55	100	A minimum of 90% of readings per month shall be less than 1.0 COH.
Suspended Particulate Matter (High-Volume Sampler)	22.81	31.58	80.00	100 $\mu g/m^3$/24hr
Total Dustfall[2]				
Residential and Recreational Area Stations		46.59		53 mg/100 cm^2/30 days
Commercial and Industrial Area Stations		94.39		158 mg/100 cm^2/30 days

[1] Clean Air (Maximum Levels) Regulations.
[2] No allowance made for normal background levels as required by (1).

TABLE 4

ANNUAL CONCENTRATION MEANS IN CALGARY*
(1977-1981)

		1977	1978	1979	1980	1981
Nitrogen Dioxide (ppm)	CDMU	0.04	0.04	0.05	0.04	0.04
	CIMU	0.03	0.03	0.03	0.02	0.02
	CRMU	0.02	0.03	0.02	0.02	0.02
Ozone (ppm)	CDMU	0.012	0.014	0.013	0.012	0.010
	CIMU	0.013	0.012	0.018	0.013	0.012
	CRMU	0.021	0.022	0.023	0.021	0.020
Carbon Monoxide (ppm)	CDMU	2.5	2.7	2.8	2.3	2.3
	CIMU	1.6	1.5	1.5	1.4	2.0
	CRMU	1.4	1.1	1.2	1.0	1.1
Total Hydrocarbons (ppm)	CDMU	2.4	2.4	2.9	2.2	2.1
	CIMU	2.0	2.1	2.0	2.2	2.3
	CRMU	2.0	2.0	2.1	1.8	1.8
Total Sulphation 28 Stations (SO_3 equiv. mg/100cm²/day)		0.16	0.16	0.15	0.24	0.21
Suspended Particulate Matter Soiling Index (COH Units)	CDMU	0.19	0.24	0.25	0.32	0.41
	CIMU	0.21	0.21	0.26	0.30	0.33
	CRMU	0.12	0.09	0.11	0.11	0.14
Suspended Particulate Matter High-Volume Sampler µg/m³ (Geometric Mean)	CDMU	79	98	130	168	150
	CIMU	91	103	143	156	134
	CRMU	53	49	61	77	67
Total Dustfall						
Residential and Recreational Area Stations (17) mg/100 cm²/30 days		56	56	58	65	63
Commercial and Industrial Area Stations (11) mg/100 cm²/30 days		84	63	76	92	87

*For years 1977-1980 inclusive, means are based on climatic year (March of one year to February of next year); 1981 means are based on calendar year.

B. OXIDES OF NITROGEN (NO_x)

Oxides of nitrogen are composed of two major constituents: nitrogen dioxide (NO_2) and the less toxic nitric oxide (NO). Both pollutants originate from natural and man-made processes. Nitrogen and oxygen, the principle constituents of the atmosphere, combine during high temperature combustion to form NO_x.[1] The major man-made source is from the burning of fossil fuels such as natural gas, coal, oil and gasoline.

In the city of Calgary, motor vehicles contribute about 65% of the oxides of nitrogen emissions, industry contributes about 18 percent, and natural gas combustion from sources such as home heating contributes 17 percent (Figure 2 - "Source and Emission Inventory").

The major oxide of nitrogen at the point of combustion is nitric oxide. A small fraction of the nitric oxide is converted to nitrogen dioxide by photochemical oxidation. Since it has been demonstrated that nitrogen dioxide can cause deleterious effects, and is the more toxic oxide of nitrogen, the emphasis here will be placed on nitrogen dioxide.

Nitrogen dioxide is an orange-brown gas with a characteristic pungent odour. Because of its colouration, it has been postulated that NO_2 is responsible for a portion of the brownish discolouration of air masses near urban areas.

The results of the monitoring of NO_2 during the 1981 report period are presented in Table 5 and Figure 2. All nitrogen dioxide levels were 100% in compliance with the Regulations. On a seasonal basis, NO_2 levels were generally lower during the spring and summer at all three stations.

TABLE 5
NITROGEN DIOXIDE/OXIDES OF NITROGEN

MAXIMUM LEVELS REGULATIONS (NO_2)
1-HOUR-0.21 PPM 24-HOUR-0.11 PPM

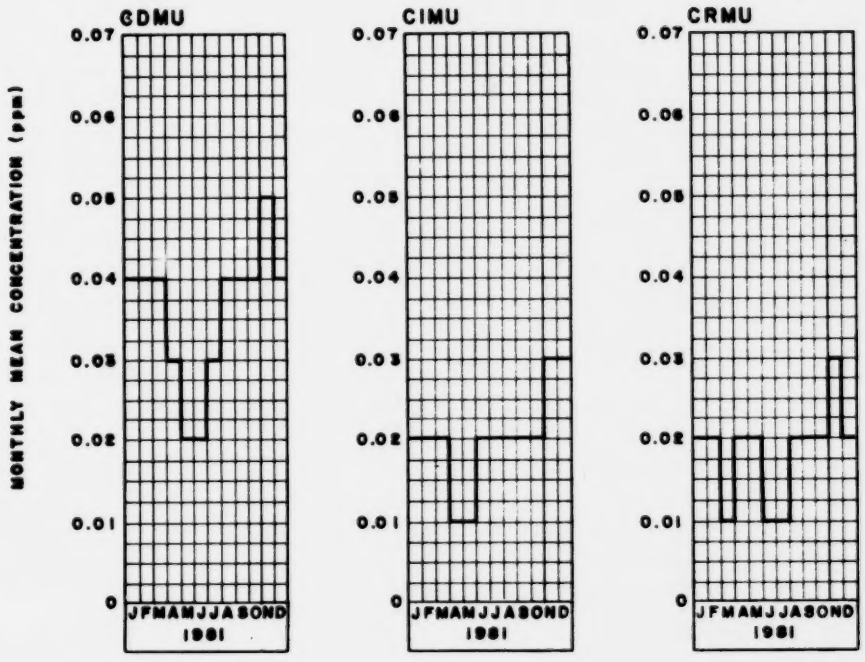
MONTH	ARITHMETIC MEAN (ppm)		PERCENTAGE OF TIME INSTRUMENT OPERATIONAL		PERCENT COMPLIANCE WITH NO_2 REGULATIONS	
	NO_2	NO_x	NO_2	NO_x	1-HR	24-HR
CDMU						
January '81	0.04	0.12	98.3	93.4	100	100
February	0.04	0.10	98.4	99.1	100	100
March	0.04	0.08	98.9	98.9	100	100
April	0.03	0.05	92.9	93.3	100	100
May	0.02	0.04	93.8	94.1	100	100
June	0.02	0.04	93.1	93.1	100	100
July	0.03	0.05	96.5	96.6	100	100
August	0.04	0.07	95.6	95.6	100	100
September	0.04	0.09	93.1	93.1	100	100
October	0.04	0.09	95.8	95.8	100	100
November	0.05	0.13	96.3	96.3	100	100
December	0.04	0.11	96.1	96.1	100	100
CIMU						
January '81	0.02	0.11	98.8	98.8	100	100
February	0.02	0.07	99.0	98.8	100	100
March	0.02	0.06	89.8	85.6	100	100
April	0.01	0.04	95.6	95.7	100	100
May	0.01	0.04	96.8	96.8	100	100
June	0.02	0.03	96.9	96.9	100	100
July	0.02	0.04	96.8	96.8	100	100
August	0.02	0.05	95.4	95.4	100	100
September	0.02	0.06	96.3	96.3	100	100
October	0.02	0.05	91.0	92.9	100	100
November	0.03	0.12	95.7	96.0	100	100
December	0.03	0.12	96.1	96.1	100	100
CRMU						
January '81	0.02	0.05	99.3	99.3	100	100
February	0.02	0.04	94.9	94.9	100	100
March	0.01	0.03	99.5	99.5	100	100
April	0.02	0.02	92.8	92.8	100	100
May	0.02	0.02	97.2	97.3	100	100
June	0.01[a]	0.02[a]	53.1	53.1	100	100
July	0.01	0.01	93.1	96.1	100	100
August	0.02	0.02	97.6	97.7	100	100
September	0.02	0.02	96.9	98.9	100	100
October	0.02	0.04	93.8	94.5	100	100
November	0.03	0.06	95.1	95.1	100	100
December	0.02	0.05	96.2	96.2	100	100

a-Instrument operational less than 75%; monthly mean may not be representative.

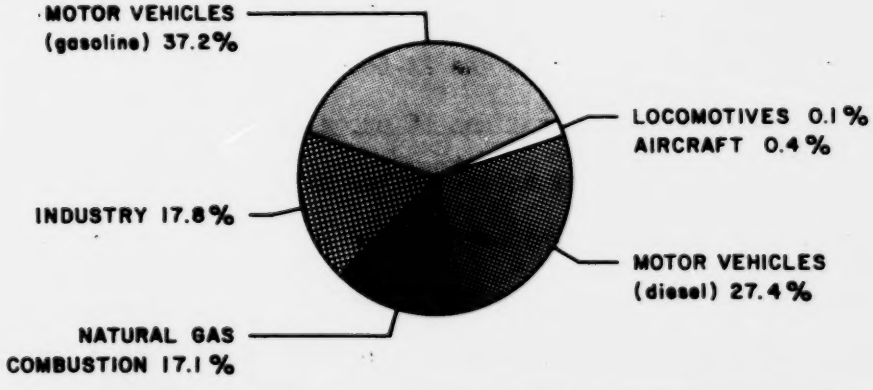
Alberta ENVIRONMENT Pollution Control Division Air Quality Control Branch

FIGURE 2 - OXIDES OF NITROGEN

NO_2 MONTHLY MEANS



SOURCE AND EMISSION INVENTORY



RELATIVE CONTRIBUTION OF EACH CATEGORY TO TOTAL OXIDES OF NITROGEN EMISSIONS IN THE CITY OF CALGARY, 1973

OXIDES OF NITROGEN
14,536 TONS

Alberta
ENVIRONMENT
Pollution Control Division

C. OZONE (O_3)

Unlike many other pollutants, ozone is not introduced directly to the air by man's activities. In the upper atmosphere, ozone is a naturally occurring constituent; in the lower atmosphere or ambient air, ozone is the primary end-product of photochemical oxidation involving the nitrogen oxides, ultraviolet light energy and reactive hydrocarbons. Ozone plays an important role in the absorption of harmful ultraviolet radiation in the upper atmosphere; however, in ambient air it can be harmful to humans, vegetation and various materials.

Table 6 and Figure 3 present a summary of the ozone data collected for this report year. The data indicate that:

1. The levels were generally highest during the spring and summer months at all three stations, and
2. The Clean Air (Maximum Levels) Regulation for the 24-hour period was exceeded during the spring and summer at CDMU and CIMU, and during the spring, summer and winter at CRMU.

The frequent occurrence of readings in excess of the 24-hour Regulation is attributable to the high natural levels of ozone in Alberta constituting what is referred to as background levels. The background levels can fluctuate depending on environmental conditions and can exceed the 24-hour Regulation.[2]

The higher concentrations of ozone recorded at CRMU, relative to CIMU and CDMU, may not be indicative of local sources but may have resulted from wind transportation of the precursors to the residential area. The elevated readings in spring and summer are indicative of the increase in ultraviolet light energy, which enhances the photochemical production of ozone.

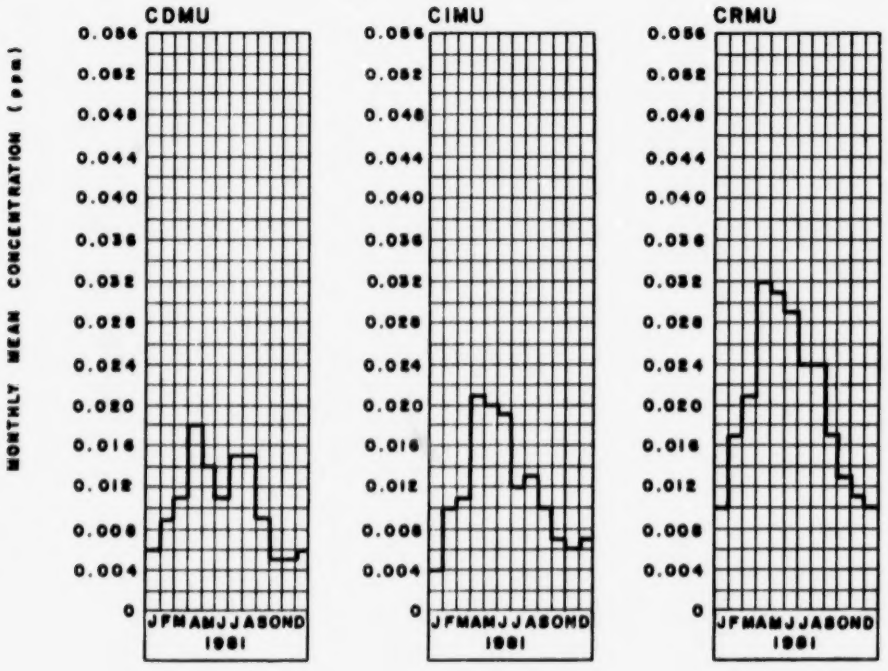
TABLE 6
OZONE

MAXIMUM LEVELS REGULATIONS
1-HOUR-0.080 PPM 24-HOUR-0.025 PPM

MONTH	ARITHMETIC MEAN (ppm)	PERCENTAGE OF TIME INSTRUMENT OPERATIONAL	PERCENT COMPLIANCE WITH REGULATIONS	
			1-HR	24-HR
CDMU				
January '81	0.006	99.7	100	100
February	0.009	99.6	100	100
March	0.011	99.5	100	100
April	0.018	95.1	100	86.0
May	0.014	96.5	100	93.3
June	0.011	97.1	100	100
July	0.015	88.6	99.8	89.1
August	0.015	93.4	100	100
September	0.009	95.6	100	100
October	0.005	95.7	100	100
November	0.005	95.7	100	100
December	0.006	95.2	100	100
CIMU				
January '81	0.004	99.6	100	100
February	0.010	99.7	100	100
March	0.011	100	100	100
April	0.021	95.1	100	72.0
May	0.020	95.4	100	89.9
June	0.019	96.3	100	93.1
July	0.012	95.7	100	100
August	0.013	95.6	100	100
September	0.010	95.7	100	100
October	0.007	94.4	100	100
November	0.006	94.6	100	100
December	0.007	95.0	100	100
CRMU				
January '81	0.010	99.7	100	100
February	0.017	91.2	100	84.3
March	0.021	99.7	100	74.1
April	0.032	95.8	100	13.0
May	0.031	96.6	100	13.2
June	0.029	95.6	100	16.3
July	0.024	96.1	100	59.7
August	0.024	96.8	99.4	56.7
September	0.017	96.4	100	100
October	0.013	97.0	100	100
November	0.011	95.6	100	100
December	0.010	95.7	100	96.6

FIGURE 3 - OZONE

MONTHLY MEANS



SOURCE AND EMISSION INVENTORY

SINCE OZONE IS PRIMARILY A PRODUCT OF PHOTOCHEMICAL REACTION, THE SOURCE AND EMISSION INVENTORY IS NOT APPLICABLE.

D. CARBON MONOXIDE (CO)

Carbon monoxide is an odourless, colourless gas. It is emitted into the atmosphere in greater quantities than any other urban air pollutant. The majority of the carbon monoxide found in urban air comes from man-made sources. Natural sources, such as forest fires and plant decay, maintain a very low background level.

The 1973 "Source and Emission Inventory" for the city of Calgary (Figure 4) indicates that motor vehicles contribute almost all of the carbon monoxide; therefore, vehicle flow patterns do influence the monitored levels at individual stations.

There were averages of 99.6% compliance and 96.2% compliance respectively with the 1-hour and the 8-hour carbon monoxide Regulations, averaged for all three monitoring stations for the report year. Vehicular traffic exhaust is responsible for the small amount of non-compliance time.

The higher carbon monoxide levels monitored at CDMU, relative to CIMU and CRMU, (Table 7 and Figure 4) are indicative of the vehicular traffic density in the downtown area. Diurnal variations of carbon monoxide levels indicate that peak levels occur during or immediately following peak rush hour periods. The data also indicate that the lowest CO concentrations were monitored during the spring and summer seasons at all three stations. This seasonal variation of CO levels results from changes in meteorological parameters. In the fall and winter, the colder ambient temperatures

result in increased production of CO emissions from motor vehicles. In addition, the more stable atmospheric conditions and low wind speeds, which occur during the fall and winter, result in decreased dispersion of CO emissions and consequently higher ground level CO concentrations, relative to spring and summer concentrations.

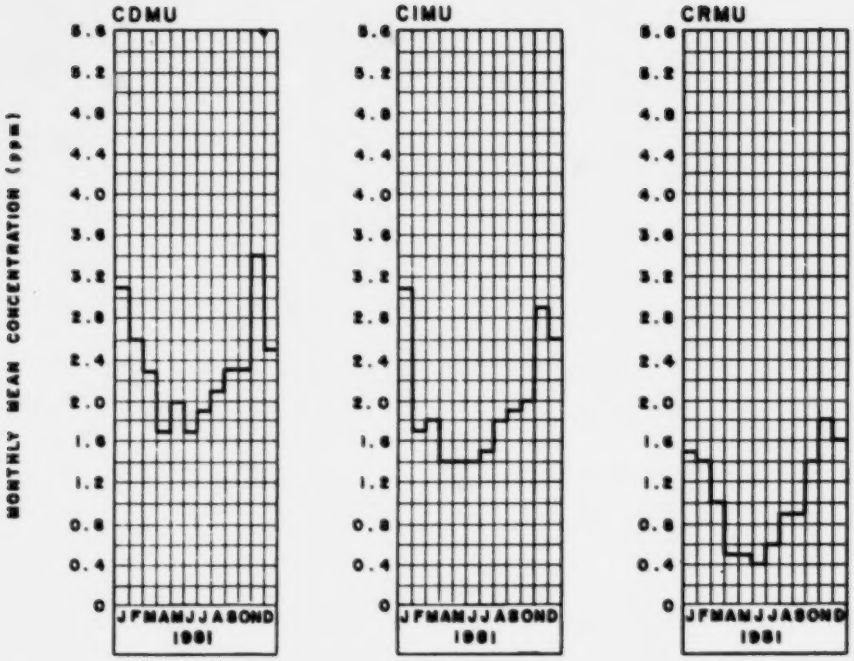
TABLE 7
CARBON MONOXIDE

MAXIMUM LEVELS REGULATIONS
1-HOUR-13 PPM 8-HOUR-5 PPM

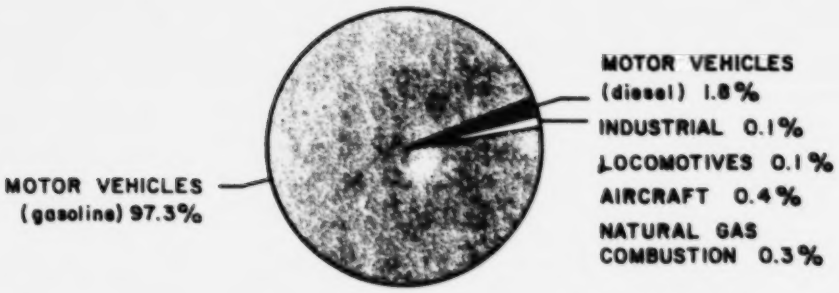
MONTH	ARITHMETIC MEAN (ppm)	PERCENTAGE OF TIME INSTRUMENT OPERATIONAL	PERCENT COMPLIANCE WITH REGULATIONS	
			1-HR	8-HR
CDMU				
January '81	3.1	98.5	98.1	82.5
February	2.6	99.9	98.4	95.2
March	2.3	99.7	99.3	95.7
April	1.7	96.0	100	100
May	2.0	94.4	100	100
June	1.7	95.8	100	100
July	1.9	96.9	100	98.9
August	2.1	93.7	100	97.7
September	2.3	98.1	99.2	95.5
October	2.3	96.9	99.6	96.7
November	3.4	93.3	97.5	81.0
December	2.5	96.5	99.0	87.7
CIMU				
January '81	3.1	90.9	98.2	83.4
February	1.7	99.9	100	98.8
March	1.8	100	100	96.8
April	1.4	96.7	100	100
May	1.4	97.4	100	100
June	1.4	93.8	100	100
July	1.5	97.6	100	100
August	1.8	97.0	100	100
September	1.9	96.4	100	100
October	2.0	96.0	99.6	97.8
November	2.9	96.0	99.4	87.3
December	2.6	96.4	99.3	87.7
CRMU				
January '81	1.5	99.9	99.7	94.6
February	1.4	100	100	98.8
March	1.0	99.9	100	98.9
April	0.5	97.6	100	100
May	0.5	97.6	100	100
June	0.4	97.2	100	100
July	0.6	82.5	100	100
August	0.9	96.8	100	100
September	0.9	97.6	99.9	98.9
October	1.4	97.7	99.9	97.8
November	1.8	96.5	99.7	94.2
December	1.6	96.2	100	95.5

FIGURE 4 - CARBON MONOXIDE

MONTHLY MEANS



SOURCE AND EMISSION INVENTORY



RELATIVE CONTRIBUTION OF EACH CATEGORY TO TOTAL CARBON MONOXIDE EMISSIONS IN THE CITY OF CALGARY, 1973

CARBON MONOXIDE
135,098 TONS

E. SULPHUR DIOXIDE (SO_2)

Sulphur dioxide constitutes one of the major air pollutants on a global basis. It may oxidize and combine with moisture to form sulphuric acid and, as such, increase its harmful effects on vegetation and the respiratory systems of humans and animals. When combined with particulate matter, it exerts a synergistic effect that is more harmful than the effect of either pollutant.

Sulphur dioxide pollution results primarily from man-made sources such as combustion of fossil fuels, smelting and roasting of sulphur containing ores, kraft and sulphite wood pulping and sour gas processing. In Alberta, an estimated 280 thousand metric tons of sulphur was emitted into the atmosphere from man-made (primarily industrial operations) sources during 1981. About 45 percent of the sulphur emissions was contributed by sulphur extraction plants; oil sands plants and power plants contributed about 25 percent and 18 percent respectively. The remaining 22 percent came from sources such as gas plant flares, oil refineries, pulp and paper mills and fertilizer plants.[3]

A summary of the sulphur dioxide data collected during the 1981 report period is presented in Table 8. All sulphur dioxide readings were well below the Regulations, resulting in 100% compliance.

Figure 5 illustrates the SO_2 "Source and Emission Inventory" for the Calgary area and includes a graph of total sulphation levels. Although the total sulphation cylinders are static monitors and yield only monthly average values, the data do provide valuable trend information and, therefore, are included in this section.

The lowest total sulphation levels of the period occurred in October (0.10 mg. SO_3 equiv./day/100 sq. cm.), with the highest levels occurring in January, February and March. All monthly mean concentration levels were below the 0.5 mg. SO_3 equiv./day/100 sq.cm. guideline (Figure 5).

TABLE 8
SULPHUR DIOXIDE

MAXIMUM LEVELS REGULATIONS
1-HOUR-0.17 PPM 24-HOUR-0.06 PPM

MONTH	ARITHMETIC MEAN (ppm)	PERCENTAGE OF TIME INSTRUMENT OPERATIONAL	PERCENT COMPLIANCE WITH REGULATIONS	
			1-HR	24-HR
CDMU				
January '81	0.00	93.8	100	100
February	0.00	99.6	100	100
March	0.00	99.3	100	100
April	0.00	98.1	100	100
May	0.00	96.2	100	100
June	0.00	97.2	100	100
July	0.00	95.6	100	100
August	0.00	95.6	100	100
September	0.01	96.7	100	100
October	0.01	95.4	100	100
November	0.01	95.8	100	100
December	0.01	95.3	100	100
CIMU				
January '81	0.00	98.0	100	100
February	0.00	95.7	100	100
March	0.00	100	100	100
April	0.00	88.3	100	100
May	0.00	95.4	100	100
June	0.00	96.3	100	100
July	0.00	95.8	100	100
August	0.00	95.6	100	100
September	0.00	95.7	100	100
October	0.00	93.5	100	100
November	0.00	94.6	100	100
December	0.00	94.5	100	100
CRMU				
January '81	0.00	99.3	100	100
February	0.00	98.7	100	100
March	0.00	99.6	100	100
April	0.00	95.6	100	100
May	0.00	96.1	100	100
June	0.00	96.0	100	100
July	0.00	96.0	100	100
August	0.00	96.2	100	100
September	0.00	95.8	100	100
October	0.00	96.6	100	100
November	0.00	95.3	100	100
December	0.00[a]	63.3	100	100

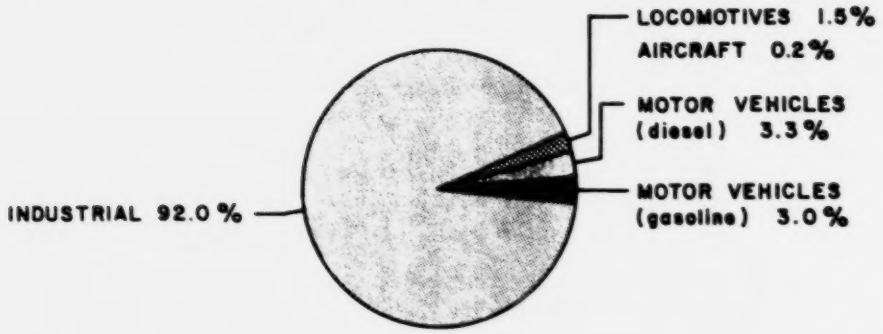
a-Instrument operational less than 75%; monthly mean may not be representative.

FIGURE 5 - SULPHUR DIOXIDE

NOTE

THE MONTHLY MEAN CONCENTRATIONS WERE LESS THAN OR EQUAL TO 0.01 ppm THROUGHOUT THE REPORT YEAR AT ALL THREE STATIONS.

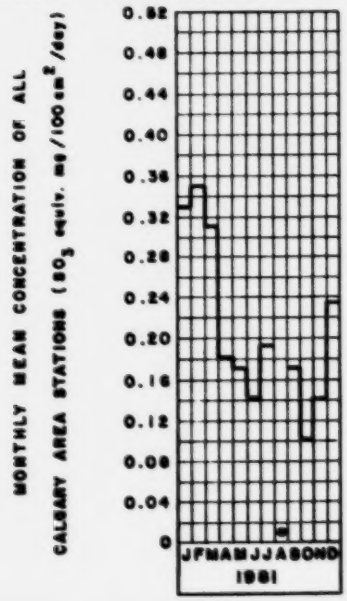
SOURCE AND EMISSION INVENTORY



RELATIVE CONTRIBUTION OF EACH CATEGORY TO TOTAL SULPHUR DIOXIDE EMISSIONS IN THE CITY OF CALGARY, 1973

SULPHUR DIOXIDE 8,661 TONS

MONTHLY MEAN TOTAL SULPHATION LEVELS



INSUFFICIENT DATA FOR CALCULATION OF MEAN.

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F. TOTAL HYDROCARBONS (THC)

The hydrocarbons considered in this section are those which exist in the atmosphere in the gaseous phase. They are important because they are precursors of compounds formed in the atmospheric photochemical system. Therefore, any assessment of the effects of hydrocarbon pollution must be made in relation to the effects of photochemical air pollution.

The natural sources of the gas-phase hydrocarbons, of which methane is a major constituent, include trees and vegetation. For man-made sources, the "Source and Emission Inventory" (Figure 6) indicates that in Calgary motor vehicles are the primary source, with industry contributing about 13 percent. The industrial emissions originate primarily from hydrocarbon storage, whereas the motor vehicle emissions result from inefficient combustion. Inefficient combustion, which occurs before the vehicle reaches operating temperature, is particularly evident during the winter.

The levels of total hydrocarbons monitored during this report period (Table 9 and Figure 6) were generally the lowest at the residential station, CRMU. On a seasonal basis, the highest levels were generally monitored during the winter months and the lowest during the summer months.

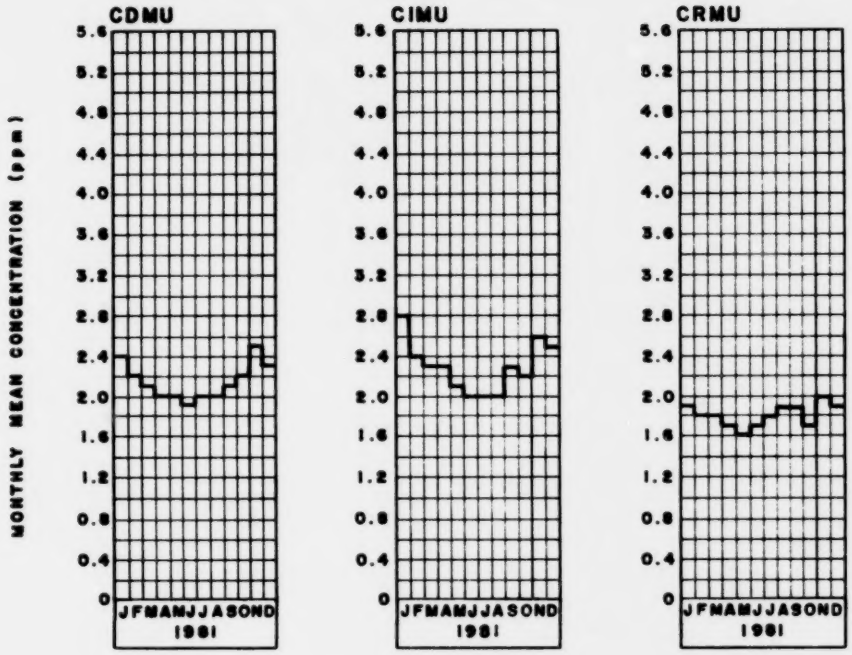
Currently there are no air quality Regulations for hydrocarbons.

TABLE 9
TOTAL HYDROCARBONS

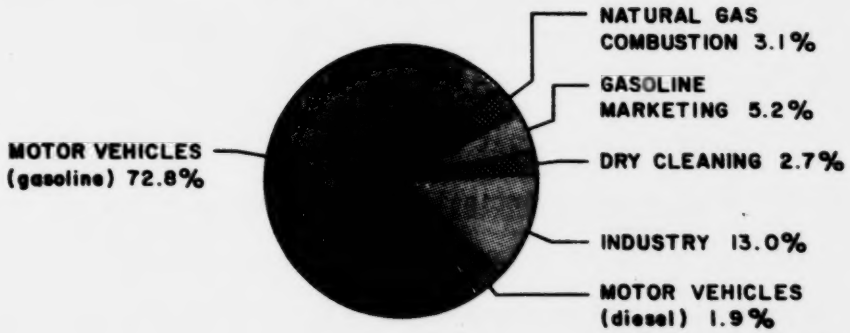
MONTH	ARITHMETIC MEAN (ppm)	PERCENTAGE OF TIME INSTRUMENT OPERATIONAL	PERCENT COMPLIANCE WITH REGULATIONS	
			1-HR	24-HR
CDMU				
January '81	2.4	96.4	NOT APPLICABLE	
February	2.2	99.9		
March	2.1	100		
April	2.0	92.1		
May	2.0	93.8		
June	1.9	97.4		
July	2.0	97.0		
August	2.0	93.5		
September	2.1	97.5		
October	2.2	97.0		
November	2.5	95.1		
December	2.3	96.9		
CIMU				
January '81	2.8	98.9	NOT APPLICABLE	
February	2.4	90.0		
March	2.3	98.9		
April	2.3	97.2		
May	2.1	97.2		
June	2.0	92.1		
July	2.0	97.3		
August	2.0	93.1		
September	2.3	96.5		
October	2.2	95.7		
November	2.6	87.8		
December	2.5	95.4		
CRMU				
January '81	1.9	99.9	NOT APPLICABLE	
February	1.8	100		
March	1.8	99.9		
April	1.7	97.8		
May	1.6	97.8		
June	1.7	96.9		
July	1.8	97.7		
August	1.9	97.2		
September	1.9	88.1		
October	1.7	97.8		
November	2.0	88.9		
December	1.9	96.4		

FIGURE 6 - TOTAL HYDROCARBONS

MONTHLY MEANS



SOURCE AND EMISSION INVENTORY



RELATIVE CONTRIBUTION OF EACH CATEGORY TO TOTAL HYDROCARBON EMISSIONS IN THE CITY OF CALGARY, 1973

HYDROCARBONS 22,661 TONS

Alberta ENVIRONMENT Pollution Control Division

G. PARTICULATES

Particulate matter is composed of a wide variety of substances and encompasses any matter dispersed in the air where the individual particles are smaller in diameter than 500 microns (μ). It is the most commonly perceived form of pollution, often manifesting itself by interference with visibility, a soiling effect on materials or as a respiratory irritant. The characteristics of particles and particle dispersion are shown in Figure 7.

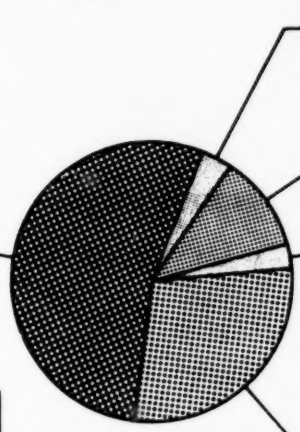
The "Source and Emission Inventory" (Figure 7) indicates that industry is the primary source of particulate emissions with natural gas combustion contributing about 28 percent. Dust from sources such as wind erosion and construction activities is not included in this inventory, although it may in fact be the greatest overall source.

In the city of Calgary, three types of sampling units are employed to measure particulate matter; therefore, the results for each type will be discussed separately in subsequent sections. The three types of samplers are the tape sampler, the high-volume sampler and the dustfall cylinder. The first two samplers measure suspended particulate matter while the latter measures total dustfall.

In general, particles smaller than 1 μ in diameter originate in the atmosphere, principally through condensation and combustion. Particles between 1 μ and 10 μ in diameter usually include soil, process dusts and combustion products from industries. Particles larger than 10 μ in diameter generally result from mechanical processes such as wind erosion, grinding, spraying and the pulverizing of materials by vehicles and pedestrians.[4]

FIGURE 7 - TOTAL PARTICULATES

SOURCE AND EMISSION INVENTORY



MOTOR VEHICLES (DIESEL) 3.4 %

MOTOR VEHICLES (GASOLINE) 11.4 %

INDUSTRIAL 53.9 %

LOCOMOTIVES 1.2 %

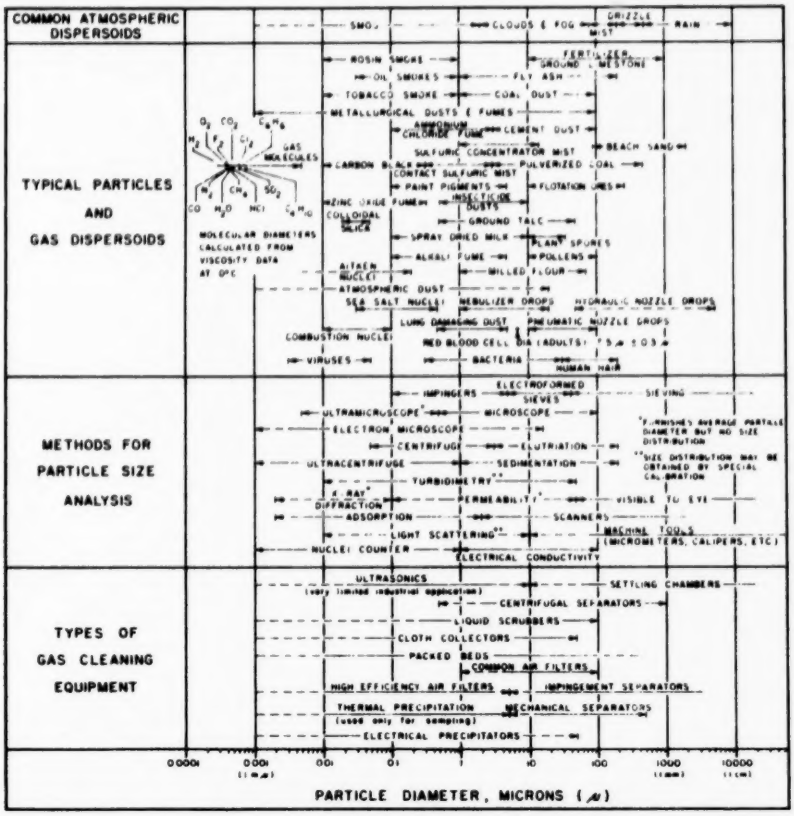
AIRCRAFT 1.8 %

NATURAL GAS COMBUSTION 28.3 %

RELATIVE CONTRIBUTION OF EACH CATEGORY TO TOTAL PARTICULATE EMISSIONS IN THE CITY OF CALGARY, 1973

PARTICULATES 3,994 TONS

CHARACTERISTICS OF PARTICLES AND PARTICLE DISPERSION



Alberta ENVIRONMENT Pollution Control Division

G. 1. SOILING INDEX

Soiling index is the usual index of suspended particulate matter in the size range of 0.1 μ to 10 μ. It is not a measure of absolute concentrations as the method of analysis does not measure the deposited mass.

The types of suspended particulate matter identified as soiling index include smoke and fine dust particles. The samples are collected by drawing sample air through a filter paper over sampling cycles of one or two hours. The soiling properties of the sample are measured by the reduction of light transmission through the filter paper. This reduction is reported as a coefficient of haze (COH) per 1,000 linear feet of air sampled.

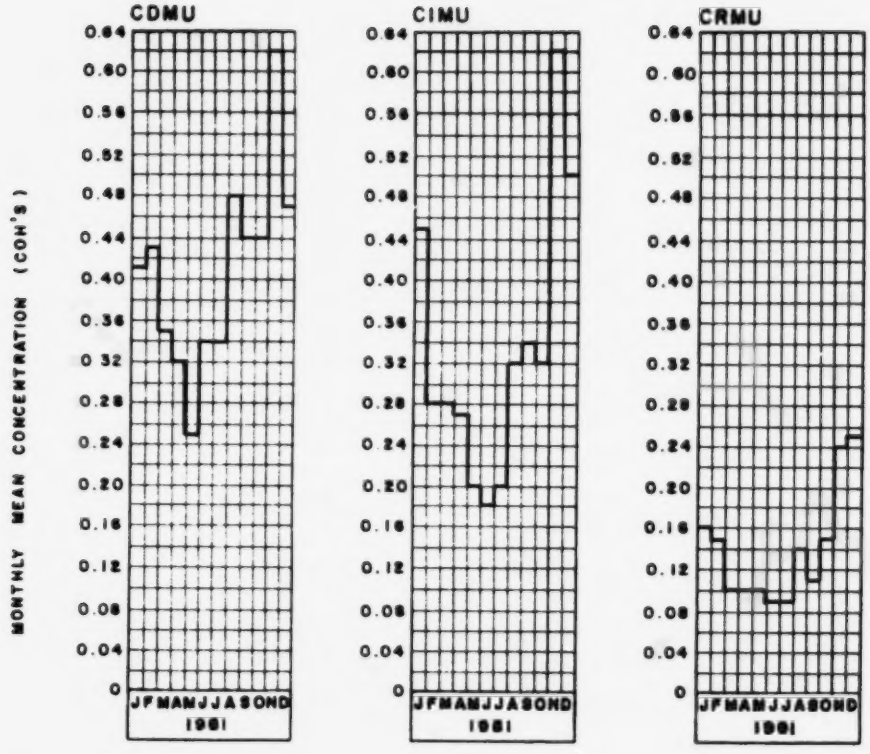
The soiling indices for this report year are summarized in Table 10. The provincial air quality guideline that "a minimum of 90% of readings per month shall be less than 1.0 COH" was complied with by all stations with the exceptions of January, November and December at CIMU and November at CDMU. Higher COH levels were recorded at CDMU and CIMU than at CRMU throughout the year (Figure 8). It is suspected that dust from construction sites may have caused these higher readings.

TABLE 10
SUSPENDED PARTICULATE MATTER/SOILING INDEX

GUIDELINE FOR SOILING INDEX
MINIMUM OF 90% OF READINGS PER MONTH
SHALL BE LESS THAN 1.0 COH

MONTH	ARITHMETIC MEAN (COH)	PERCENTAGE OF TIME INSTRUMENT OPERATIONAL	PERCENT OF READINGS LESS THAN 1.0 COH
		CDMU	
January '81	0.41	98.8	92.5
February	0.43	91.5	95.1
March	0.35	96.1	95.2
April	0.32	99.3	96.6
May	0.25	100	98.1
June	0.34	98.3	97.3
July	0.34	100	97.6
August	0.48	100	91.1
September	0.44	100	91.9
October	0.44	100	93.3
November	0.62	100	83.5
December	0.47	100	92.2
		CIMU	
January '81	0.45	100	89.1
February	0.28	100	96.6
March	0.28	96.4	94.8
April	0.27	99.9	98.1
May	0.20	96.2	99.7
June	0.18	98.1	99.6
July	0.20	99.3	99.9
August	0.32	95.7	97.8
September	0.34	98.1	94.6
October	0.32	100	95.0
November	0.62	98.6	83.0
December	0.50	99.7	87.7
		CRMU	
January '81	0.16	99.1	98.9
February	0.15	100	99.0
March	0.10	100	100
April	0.10	100	100
May	0.10	100	100
June	0.09	98.9	100
July	0.09	90.2	100
August	0.14	100	99.9
September	0.11	99.9	100
October	0.15	98.3	98.9
November	0.24	98.2	96.3
December	0.25	100	97.8

FIGURE 8 - SOILING INDEX



G. 2. HIGH-VOLUME SAMPLER

Suspended particulate matter is also measured by the high-volume sampler. The sampler consists of a vacuum system and filter housed in a shelter. Suspended particulate matter in the atmosphere is determined by collecting 24-hour samples on the pre-weighed filter. The filter is then reweighed to determine the mass of the particles collected. This method gives a more accurate measurement of suspended particulate matter than the soiling index monitor.

The size of particles collected by the high-volume sampler range from 0.1 μ to 10 μ.

The levels of suspended particulate matter measured by the high-volume sampler (Table 11 and Figure 9) were occasionally in excess of the Clean Air (Maximum Levels) Regulation of 100 $\mu g/m^3$/24-hour at all three stations.

There was an average of 44.8% compliance achieved with the Regulation for suspended particulate matter, averaged for all three monitoring stations over the report year. Blowing dust from roads, surrounding fields, construction sites, gardens, etc. are sources which could have contributed to the periods of non-compliance.

TABLE 11
SUSPENDED PARTICULATE MATTER/HIGH-VOLUME SAMPLER

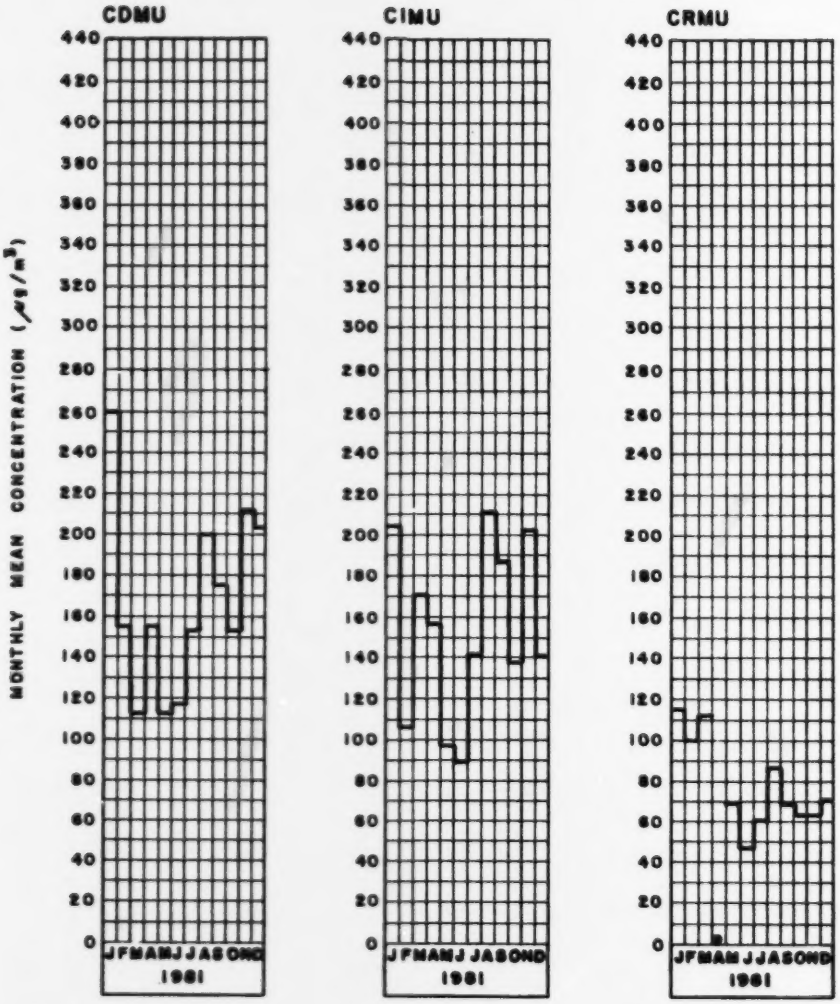
MAXIMUM LEVELS REGULATIONS
24-HOUR-100 $\mu g/m^3$

MONTH	ARITHMETIC MEAN ($\mu g/m^3$)	PERCENTAGE OF TIME INSTRUMENT OPERATIONAL	PERCENT COMPLIANCE WITH REGULATION
		CDMU	
January '81	260	100	20
February	156	100	20
March	112	100	40
April	156	100	0
May	112	100	40
June	117	100	40
July	154[a]	60	0
August	200	100	20
September	176	100	0
October	155	83	20
November	212	100	20
December	204	80	0
		CIMU	
January '81	205	100	20
February	107	100	40
March	171	100	20
April	158	100	20
May	98	80	50
June	91	100	60
July	143[a]	60	33
August	212	100	20
September	188	100	20
October	137	100	33
November	203	100	20
December	142	100	40
		CRMU	
January '81	116	100	40
February	101	100	40
March	114	80	75
April	b	40	100
May	69[a]	60	100
June	48	100	100
July	61[a]	60	100
August	88	100	80
September	70	100	80
October	64	83	80
November	64	100	80
December	72	80	75

a-Instrument operational less than 75%; monthly mean may not be representative.
b-Instrument operational less than 50%; insufficient data for calculation of mean.

FIGURE 9 - SUSPENDED PARTICULATE MATTER: HIGH - VOLUME SAMPLER

MONTHLY MEANS



• INSUFFICIENT DATA FOR CALCULATION OF MEAN.

G.3. TOTAL DUSTFALL

Total dustfall includes particles in the size range greater than 10μ. Since these particles have appreciable settling capabilities, they are collected by deposition in a dustfall jar or cylinder. The dustfall cylinders are generally exposed for 30-day periods and yield integrated dustfall values for that period.

The large particles collected by dustfall cylinders settle readily at low velocities. Therefore, total dustfall cylinders provide a measure of dust arising from local sources. Quite often high dustfall levels are attributable to nearby construction or vehicular traffic on a dusty road.

The results of the monitoring of total dustfall during the 1981 report period are presented in Table 12 and Figure 10. The readings are actual measured levels and are not corrected for "normal background levels." The data indicate that, on a seasonal basis, the lowest levels were monitored during the winter months at both the residential-recreational area stations, and the commercial-industrial area stations.

When the total dustfall levels are compared with the Clean Air (Maximum Levels) Regulations, which distinguish between residential-recreational (53 mg/100 cm^2/30 days) and commercial-industrial (158 mg/100 cm^2/30 days) areas, a high frequency of readings in excess of the Regulations is noted in the residential-recreational area.

There were averages of 46.6% compliance and 94.4% compliance respectively with the residential/recreational area and the commercial/industrial area total dustfall Regulations. Blowing dust from roads, surrounding fields, construction sites, gardens, etc. are sources which could have contributed to the periods of non-compliance.

TABLE 12

TOTAL DUSTFALL

MAXIMUM LEVELS REGULATIONS
53 mg/100 cm^2/30 days in residential and recreational areas.
158 mg/100 cm^2/30 days in commercial and industrial areas.

RESIDENTIAL AND RECREATIONAL AREA STATIONS

MONTH	ARITHMETIC MEAN (mg/100 cm^2 /30 days)	PERCENTAGE OF STATIONS REPORTING DATA	PERCENTAGE OF STATIONS IN COMPLIANCE WITH REGULATIONS
January '81	54	94	69
February	48	100	59
March	74	88	20
April	51	100	59
May	109	88	13
June	68	94	31
July	77	88	27
August	No Data		
September	56	100	59
October	75	88	33
November	47	94	56
December	46	100	76

COMMERCIAL AND INDUSTRIAL AREA STATIONS

January '81	51	100	100
February	51	100	100
March	101	91	100
April	72	91	100
May	159	91	70
June	83	91	100
July	107	91	80
August	No Data		
September	57[a]	73	100
October	179[a]	64	86
November	63	82	100
December	44	100	100

a-Instrument operational less than 75%; monthly mean may not be representative.

Alberta
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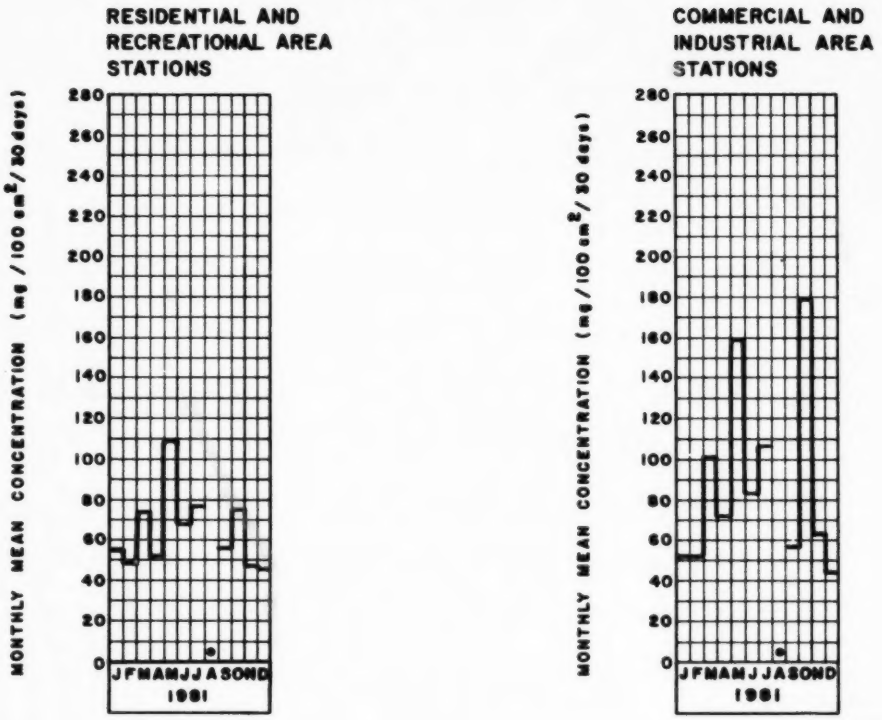
FIGURE 10 - TOTAL DUSTFALL

MONTHLY MEANS



• INSUFFICIENT DATA FOR CALCULATION OF MEAN.

V. INDEX OF THE QUALITY OF THE AIR (IQUA)

The IQUA is an indicator of the status of existing air quality. It is based on the 1-hour and 24-hour concentrations of nitrogen dioxide, sulphur dioxide, and soiling index (COH), on the 1-hour and 8-hour concentrations of carbon monoxide, and on the 1-hour concentrations of ozone. An index is calculated for each of the five pollutants. The maximum index is then used as the numerical value of IQUA. An IQUA reading of 0-25 indicates good air quality, 26-50 is fair, 51-100 is poor and greater than 100 is very poor.

In Calgary, IQUA is calculated at three locations: CDMU, CRMU and CIMU, with the index made available to the media and public routinely. It is issued at 0800 and 1600 hours on weekdays, except when the index values are greater than 50. In the latter case, it is generally issued every hour until the index value falls below 50.

A summary of the air quality indices for the three monitoring stations is presented in Table 13. During the report year, the air quality was generally good (0-25 as an arithmetic mean). On occasion, however, index values in the 'very poor' category were observed, especially during the fall and winter at CDMU and CIMU. Such values were usually a result of high soiling index levels (1-hour average) or carbon monoxide levels (8-hour average).

TABLE 13

INDEX OF THE QUALITY OF THE AIR (IQUA)

	CDMU	CIMU	CRMU
MONTH	ARITHMETIC MEAN	ARITHMETIC MEAN	ARITHMETIC MEAN
January '81	25	25	13
February	23	16	14
March	21	16	13
April	18	18	17
May	16	13	17
June	18	12	15
July	19	11	13
August	26	17	15
September	24	18	12
October	23	18	12
November	33	32	16
December	27	27	16

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VI. SUMMARY AND CONCLUSIONS

From the foregoing analysis of the data, the following can be concluded:

1. During the report year the air quality index in the Calgary area was generally in the "good" index range (0-25 as an arithmetic mean).
2. All nitrogen dioxide readings were 100% in compliance with the Regulations.
3. High natural background ozone levels in Alberta resulted in a significant number of readings in excess of the 24-hour ozone Regulation. There was an average of 87.2% compliance with the 24-hour ozone Regulation averaged for all three monitoring stations for the report year. Good compliance was achieved with the 1-hour ozone Regulation (average of 99.98% compliance for all three monitoring stations for the report year).
4. There were averages of 99.6% compliance and 96.2% compliance respectively with the 1-hour and the 8-hour carbon monoxide Regulations, averaged for all three monitoring stations for the report year. Vehicular traffic exhaust is responsible for the small amount of non-compliance time.
5. All sulphur dioxide readings were well below the Regulations, resulting in 100% compliance.

6. All soiling index (coefficient of haze-COH) readings were 100% in compliance with the Alberta guideline, with the exceptions of January, November and December at CIMU and November at CDMU.

7. There was an average of 44.8% compliance achieved with the Regulation for suspended particulate matter (0.1 μ to 10 μ size range), averaged for all three monitoring stations over the report year. Blowing dust from roads, surrounding fields, construction sites, gardens, etc. are sources which could have contributed to the periods of non-compliance.

8. There were averages of 46.6% compliance and 94.4% compliance respectively with the residential/recreational area and the commercial/industrial area total dustfall (greater than 10 μ size) Regulations. Blowing dust from roads, surrounding fields, construction sites, gardens, etc. are sources which could have contributed to the periods of non-compliance.

VII. REFERENCES

1. U.S. Department of Health, Education, and Welfare. Air Quality Criteria for Nitrogen Oxides. (NAPCA Publication No. AP-84. Washington, D.C., January 1971); sec. 11, p. 8.

2. Alberta Environment, Research Secretariat. A Study of Photochemical Air Pollutants in the Urban Airsheds of Edmonton and Calgary, H. S. Sandhu. (Staff Report #1. Edmonton, Alberta, 1975).

3. Alberta Environment. Industrial Sulphur Emissions for Alberta 1977-1981, prepared by Alberta Environment, Pollution Control Division, Air Quality Control Branch. September, 1982.

4. U.S. Department of Health, Education, and Welfare. Air Quality Criteria for Particulate Matter. (NAPCA Publication No. AP-49. Washington, D.C., January 1969); p. 181.